

CLAIMS

What is claimed is

1. In a **wireless communication system** comprising a **main transceiver** and a **remote transceiver** capable of receiving signals from and transmitting signals to the main transceiver, the main transceiver comprising an **array of transmit antenna elements**, and at least one **receive antenna element**, each transmit antenna element being part of a **transmit electronics chain** for transmitting a **transmit apparatus signal** using the transmit antenna element, and each receive antenna element being part of a **receiver apparatus chain** for receiving a **received antenna signal** from the receive antenna element, the main transceiver and the remote transceiver designed for mutual communication using waveforms conforming to an **air interface standard**, a **method** for estimating the downlink signature for the remote transceiver, the method comprising:

- (a) **transmitting a set of one or more downlink calibration waveforms** from the main transceiver via the transmit antenna array to the remote transceiver, the set of downlink calibration waveforms substantially conforming to the air interface standard;
- (b) **processing the signals received at the remote transceiver corresponding to the downlink calibration waveforms**, the processing to determine **downlink signature related signals** related to the downlink signature for the remote transceiver;
- (c) **transmitting the downlink signature related signals** from the remote transceiver to the main transceiver using waveforms substantially conforming to the air interface standard; and
- (d) **determining the downlink signature of the remote transceiver from the downlink signature related signals received at the main transceiver.**

2. The method of claim 1, wherein the at least one receive antenna element are a plurality of receive antenna elements forming an **array of receive antenna**

elements, the number of elements in the array of receive antenna elements being the same as the number of antenna elements in the array of transmit antenna elements, the method further comprising:

- (e) transmitting a set of one or more uplink calibration waveforms from the remote transceiver to the main transceiver, the set of downlink calibration waveforms substantially conforming to the air interface standard;
- (f) processing at the main transceiver the received antenna signals corresponding to the uplink calibration signals transmitted from the remote transceiver, the processing determining the uplink signature for the remote transceiver; and
- (h) determining a calibration function for the main transceiver from the uplink and downlink signatures for the remote transceiver.

3. In a wireless communication system comprising a main transceiver and a remote transceiver capable of receiving signals from and transmitting signals to the main transceiver, the main transceiver comprising an array of transmit antenna elements, and at least one receive antenna element, each transmit antenna element being part of a transmit electronics chain for transmitting a transmit apparatus signal using the transmit antenna element, and each receive antenna element being part of a receiver apparatus chain for receiving a received antenna signal from the receive antenna element, the main transceiver and the remote transceiver designed for mutual communication using waveforms conforming to an air interface standard, a method for estimating the downlink signature for the remote transceiver, the method comprising:

- (a) transmitting a set of one or more downlink calibration waveforms from the main transceiver via the transmit antenna array to the remote transceiver, the set of downlink calibration waveforms designed to be robust to one or more of the set comprising frequency offset, phase noise, I/Q mismatch, and timing offset;

- (b) **processing the signals received at the remote transceiver corresponding to the downlink calibration waveforms, the processing to determine downlink signature related signals related to the downlink signature for the remote transceiver;**
- 5 (c) **transmitting the downlink signature related signals from the remote transceiver to the main transceiver; and**
- (d) **determining the downlink signature of the remote transceiver from the downlink signature related signals received at the main transceiver.**
- 4. The method of claim 3, wherein the at least one receive antenna element are a
 - 10 plurality of receive antenna elements forming an array of receive antenna elements, the number of elements in the array of receive antenna elements being the same as the number of antenna elements in the array of transmit antenna elements, the method further comprising:
 - (e) **transmitting a set of one or more uplink calibration waveforms from**
 - 15 the remote transceiver to the main transceiver, the set of downlink calibration waveforms;
 - (f) **processing at the main transceiver the received antenna signals corresponding to the uplink calibration signals transmitted from the remote transceiver, the processing determining the uplink signature for the remote**
 - 20 transceiver; and
 - (g) **determining a calibration function for the main transceiver from the uplink and downlink signatures for the remote transceiver.**
- 5. The method of claim 3, wherein each of the set of downlink calibration waveforms conforms to the air interface standard.
- 25 6. In a wireless communication system comprising a main transceiver and a remote transceiver capable of receiving signals from and transmitting signals to the main transceiver, the main transceiver comprising an array of transmit antenna elements, and at least one receive antenna element, each transmit antenna element being part of a transmit electronics chain for transmitting a transmit apparatus

signal using the transmit antenna element, and each receive element being part of a receiver apparatus chain for receiving a received antenna signal from the receive antenna element, the main communication transceiver designed to transmit traffic waveforms, the main communication transceiver also designed to transmit
 5 downlink calibration waveforms, a method for estimating the downlink signature for the remote transceiver, the method comprising:

- (a) transmitting downlink calibration waveforms and traffic waveforms from the main transceiver via the transmit antenna array to the remote transceiver, the downlink calibration waveforms interspersed with the traffic waveforms;
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- (b) determining at the remote transceiver whether the signals received at the remote transceiver correspond to downlink calibration waveforms or to traffic waveforms;
- (c) processing signals received at the remote transceiver determined in step
 15 (b) to correspond to downlink calibration waveforms, the processing to determine downlink signature related signals related to the downlink signature for the remote transceiver;
- (d) processing signals received at the remote transceiver determined in step
 20 (b) to correspond to traffic waveforms, the processing to perform normal traffic functions;
- (e) transmitting the downlink signature related signals from the remote transceiver to the main transceiver; and
- (f) determining the downlink signature of the remote transceiver from the downlink signature related signals received at the main transceiver.

25 7. The method of claim 6, wherein the downlink calibration waveforms are transmitted during silent periods.

8. The method of claim 6, wherein the downlink calibration waveforms are transmitted only after a number of idle waveforms are transmitted from the main transceiver.